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APPLIED OF PHYTOPLANKTON INDEX OF BIOLOGICAL INTEGRITY (P-IBI) FOR ASSESSMENT OF ENVIRONMEN CHANGES IN THE EUPHRATES RIVER IN Al-NASSIRYIA CITY/ IRAQ

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ABSTRACT

Indices of Biological Integrity (IBIs) are being increasingly used as useful and direct tools for assessing general health of aquatic ecosystems. Eight metrics were selected for measuring P-IBI for the Euphrates river in Al-Nassiryia city in Iraq. The mean P-IBI scores showed better conditions in station 1 (Good) in autumn 2014 as compared to the station 2 (Poor)in summer2014 & station 3 (Poor) in winter 2015. However, the results generally indicated higher in autumn . Among the eight metrics comprising the index, total number of phytoplankton, relative abundance of Pennales had the most prominent effect on the P-IBI value in the station 2,3. Metrics such as Richness index and relative abundance of Cyanophyceae and Chlorophyceae also played a significant role in determining the index value. Continuous monitoring based on the selection of the most suitable metrics is recommended.

KEYWORDS: Assessment, IBI, Nature Iraq, Euphrates River, Al-Nassiryia City, Aquatic Ecology

INTRODUCTION

Index of biological Integrity (IBI) has been proven to be an important assessment tool for evaluating the resource quality of aquatic ecosystems (Gammon and Simon 2000). Multimetric indices are increasingly common as resource and ecosystem management tools and are often more robust than their component metrics (Lacouture et al., 2006).

In general the biological integrity is an ecosystem property that can be defined as the capability to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981).

Karr (1981) was the first who devised an Index of Biological Integrity to measure biological integrity in a stream, using fish as indicator species. The index was then developed to help in evaluating the conditions of a small warm water stream in Central Illinois and Indiana (Karr and Chu 1997).

The phytoplankton index of biological integrity (P-IBI) has been proved to be a management tool to assess phytoplankton community status relative to nutrient and light conditions in an ecosystem (Lacouture *et al*., 2006).

Different measures of phytoplankton taxonomy, abundance and biomass have been used extensively to document the effects of eutrophication (Smayda 1989; Pinckney *et al*., 2001). Multible phytoplankton metrics have been used in

ecosystem indices for several estuaries (Alden III et *al*., 2002). Phytoplankton has been used as indicators of nutrient conditions as well as pollution in water (APHA *et al*., 2005). Rawson (1956) discussed the ratio of centric to pennate diatoms as being indicator of trophic conditions. Trophic status of any water body may be indicated by different phytoplankton taxa or a number of ratios between different groups (Hutchinson, 1967). Diatoms could be used for monitoring environmental changes including changes in trophic status of water bodies (Dixit *et al*., 1992). The purpose of the present project is to apply a metric index of biological integrity for phytoplankton to be used in the evaluation of the health of the Euphrates river' water in southern Iraq.

MATERIAL AND METHODS

Study Area Discrption

The study area included 4 stations on Euphrates river in Al-Nassiryia city, the first station located at the entrance of the river to Al-Nassiria city and far from the second station by 10 km which located at convergence (junction) zone of hot water emerging from the thermal electric power station with the river. The third station located at convergence zone stream discharge waste water, while the fourth station located before the river leaving the city of Al-Nassiryia and far from the third station by 10 km. Fig.(1)

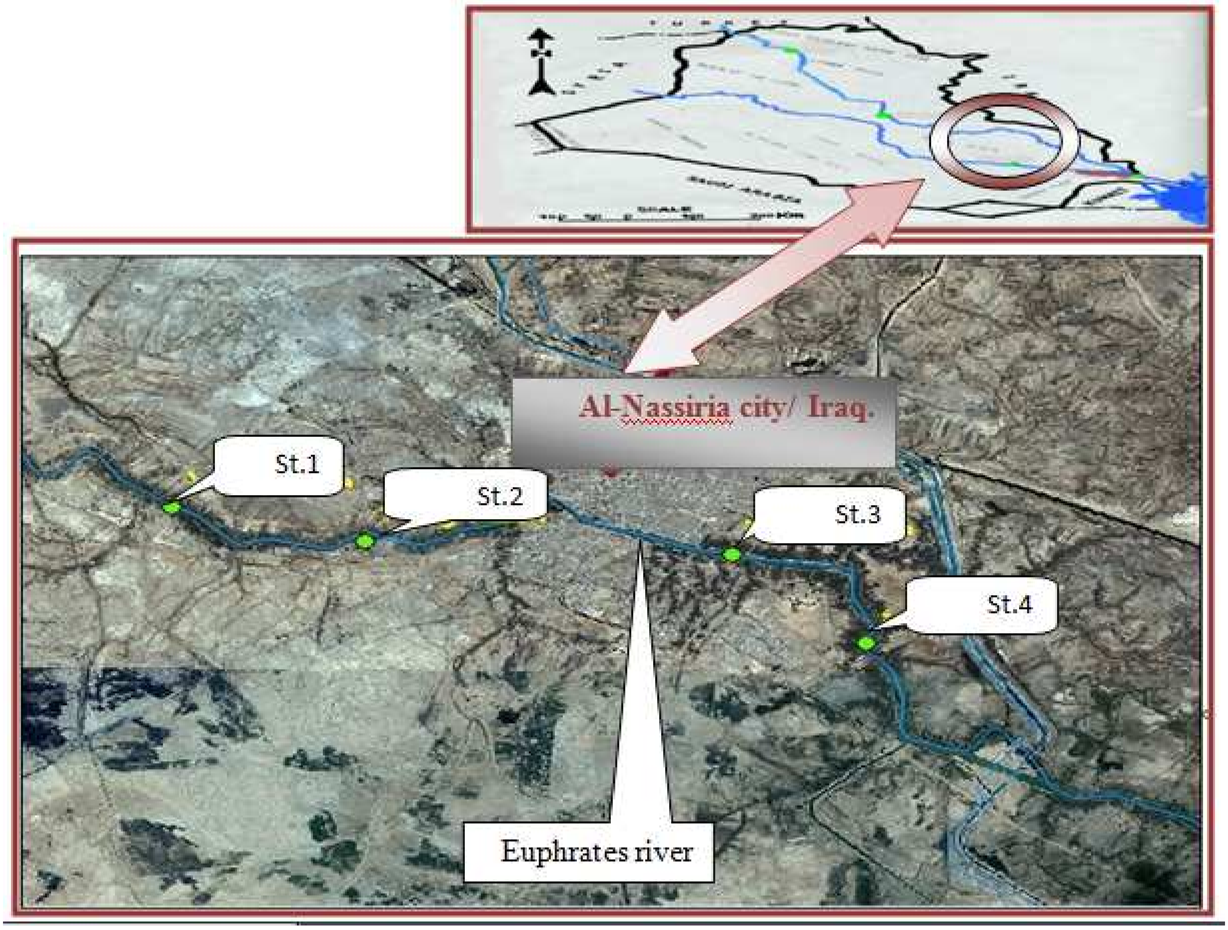

Figure 1*:* Map of the Study Stations (St.)

Sampling

Subsurface water samples were collected from the middle and two banks of the Euphrates river during summer 2014 to spring 2015, the phytoplankton samples were collected two samples per month from each station. Phytoplankton samples were taken by a 20 µ mesh size net. Known volume of water was filtered for quantity studies. Identification of species was done by a compound microscope and the following references (Prescott, 1982; Germain , 1981).

Total density of species was calculated by the sum of monthly densities of each species. Then species were placed according to proper metrics. Phytoplankton metrics used for this analysis included: phytoplankton density (cell/L3), relative abundance of Centrales, relative abundance of Pennales, relative abundance of Xanthophyceae, relative abundance of Chlorophyceae, relative abundance of Cyanophyceae, relative abundance of Pyrrhophyeae and richness inde

Metric raw data (percentages of densities) were converted into metric scores after being subjected to a scale of thresholds of 3, 5 and 10 (Astin, 2007) (Table 1). The development of these thresholds was performed according to (Al-Nimma, 1982; Al-Saadi *et al*., 2000; AL-Haidarey *et al*., 2005) based on the existing historical data and professional judgment. Thus, a threshold f 10 was given for metrics that has values equal or near to reference condition, 5 was given to those of medium conditions and 3 to those of worst conditions. In addition, according to Astin (2007), these values reflect those more traditional measures of trophic status. The sums of these metric scores for each site were calculated seasonally as the P-IBI. The final index scores were grouped in four rating categories of “Excel-lent”, “Good”, “Fair”, “Poor” and “Very Poor” as in Table 2 (McCormick *et al.*, 2001; Maulood *et al*.,2011). A value close to 82 indicates that streams biology is equivalent to what would be found in a natural condition. A value close to 56 indicates a poor biological condition within the ecosystem. Table 2 shows the cutoff values for the IBI scores and qualitative interpretation (McCormick *et al.*, 2001 ; Maulood *et al*.,2011). The P-IBI values were categorized as Excellent, Good, Fair, Poor and Very Poor according to McCormick *et al.,* 2001 and Maulood *et al*., 2011. The minimal and maximal cutoff values for each category represent the outcome of multiplying the minimal (*i.e.*, 3) and the maximal (*i.e.*, 10) scoring criteria by collected the values of the metric scores hit in ten then divided by the number of metric scores.to..ensure.that..the.resulting.number..did. not.skip..number.100..in.any.case

Table 1: Scoring Criteria of Different Sites of the Euphrates River

Metrics	3	5Scoring Criteria	10
Phytoplankton Density	>3236000	168000 – 3236000	<168000
R.A. of Cyanophyceae	>11.92%	1.14 -11.92%	<1.14%
R.A. of Centrales	>40%	14.9 – 40%	<14.9%
R.A. of Pennales	<56.5%	97.12-56.5%	>97.12%
R.A. of Chlorophyceae	<2.25%	24 - 2.25%	%>24
R.A. of Pyrrhophyceae	>5.3%	3.4 - 5.3%	<3.4%
R.A.of Xanthophyceae	<0.87%	3.02 - 0.87%	>3.02%
Richness Index	<3.15	5.63 - 3.15	>5.63

Table 2: Cutoff Values of IBI Scores and Relevant Qualitative Interpretations for Ecosystem Condition

Ecosystem Condition	Metric IBI Score
Excellent	<82
Good	72 -82
Fair	56 - 72
Poor	>56

RESULTS AND DISCUSSIONS

The results of P-IBI ranged between 52.5 - 75 (poor to good ecosystem condition) indicating the fluctuation in the status of these sites. The higher values were observed in station 1 during autumn 2014, while the lower values were observed in station 2 during summer 2014 (Table 3) .Generally values of P-IBI were lower in summer in station 2 in comparison to autumn in station 1. This might be because of the decrease in population of diatoms, and the increase in percentage of Cyanophyceae during summer season, while the lower values in station 3 during winter 2015 might be because of Severe environmental conditions that have affected negatively on the growth of diatoms (Tables 5, 6, 7).

Table 3: Seasonal Variation for P-IBI for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
st1	66.25	75	66.25	66.25
st2	52.5	66.25	63.75	66.25
st3	57.5	66.25	52.5	63.75
st4	57.5	62.5	66.25	60

Two main maxima in the total cell nember can be distinguished at all the studied stations, the first occurred in autumn and the second during spring (Table 4). The seasonal variations in phytoplankton population may be to the changes in the environmental factors (Antoine and AL-Saadi 1982). Station 3 showed higher total cell counts, which may be attributed to the high nutrient values received as domestic disposal that discharge in this station (Hassan,1993)

Table 4: Seasonal Variation of the Total Number of Phytoplankton (Cell*103/L) for All Stations of THIS Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St.1	925.77	2730.34	986.91	2665.62
St.2	961.42	2723.18	1886.34	2794.5
St.3	1412.14	3583.41	1024.35	3398.1
St.4	727.74	2308.16	758.31	2633.31

The result showed that seasonal variations occurred between seasons and in some species of phytoplankton, relative abundance of Pennales had higher winter and autumn mean abundance than wet season(summer) but the relative abundance of centrales was against that(Table 5,6). This may be attributed to the Deterioration of water quality in the study area

Table 5: Seasonal Variation for Relative Abundance of Centrales for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter2015	Spring2015
St. 1	3.72	6.93	8.7	6.44
St. 2	3.58	6.3	9.21	4.29
St. 3	8.5	10.56	18.48	14.42
St. 4	2.36	3.34	4.7	5.21

Table 6: Seasonal Variation for Relative Abundance of Pennales for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St.1	66.96	102.2	60.9	60.86
St. 2	51.9	83.25	67.37	75.57
St. 3	47.41	60.72	47.04	61.34
St. 4	57.85	73.31	75.58	62.9

Chlorophyceae were the second most important group. They contributed a large number of species but lower cells numbers compared with Bacillariophyceae. This group is the most abundant flora in winter and spring(Table 7) , which may be due to their preference for moderate . Other factors may include higher efficiency of light absorption and nutrient uptake (Szelag-Wasielewska, 2003).

Table 7: Seasonal Variation for Relative Abundance of Chlorophyceae for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St. 1	11.5	3.9	10.8	12
St. 2	0.02	1.95	9.01	6.48
St. 3	8.32	12.49	1.21	5
St. 4	13.34	12.9	19.34	22.63

Other classes of phytoplankton (Cyanophyceae, Pyrrhophyeae ,Xanthophyceae and Euglenophyceae) were abundant only seasonally and with minor numerical importance(Table 8,9,10). The overall results of this study indicate that the down regions of the Euphrates River in Iraq have phytoplankton indicative of oligotrophic conditions, with perhaps some indication of organic

pollution near the cities.

Table 8: Seasonal Variation for Relative Abundance of Cyanophyceae for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St. 1	16.1	6.26	4.33	4.8
St. 2	30.03	5.47	12.42	8.38
St. 3	30.98	12.19	18.74	12.52
St. 4	17.59	3.64	11.77	4.05

Table 9: Seasonal Variation for Relative Abundance of Pyrrhophyeae for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St. 1	1.15	1.56	1.08	0.8
St. 2	3.35	0.78	1.12	0.76
St. 3	2.27	1.48	0	0.31
St. 4	2.93	4.61	0	4.62

Table 10: Seasonal Variation for Relative Abundance of Xanthophyceae for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter 2015	Spring2015
St. 1	1.15	2.73	0	0.4
St. 2	0	1.17	0.56	0.76
St. 3	2.27	0.89	0	0
St. 4	0	1.38	0	0.4

Higher values of species richness index were recorded during the spring season in station 1 than the summer season that recorded lower values in station 2 (Table 11) .In the station 1 species diversity was relatively high, which indicates good environmental conditions conducive to the development of many species (Kajak, 1983) - moderate trophy of waters. It was only in summer season samples that values were much lower which was reflected by the lowest recorded number of species as well as by the domination of single species, accompanied.by.low.proportions..of.other.taxa.(Rogozin,2000).

Table 11: Seasonal Variation for Species Richness Index for all Stations of this Study

Season / Station	Summer2014	Autumn2014	Winter2015	Spring2015
st1	7.61	8.59	7.97	8.87
st2	4.65	7.45	8.48	7.43
st3	5.23	8.79	6.34	8.36
st4	5	6.97	6.33	7.87

CONCLUSIONS

The multimetric P-IBI can provide a useful, broad-scale way to monitor changes in the water quality of the Euphrates River in Iraq. The decline in Euphrates River P -IBI score during summer 2014 reflect the changing trophic status of the River. Further, the P-IBI is a new tool for measuring water quality of Euphrates River and can be used to monitor changes in these river stemming from anthropogenic stressors, such as nutrient addition.

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